

Amendments to the Claims

The following claim listing replaces all previous claim listings in the application:

1. (Previously presented) An integrated process for extracting and purifying tocotrienols/tocopherols, carotenoids and sterols and production of fatty acid esters from oils, comprising the steps of:
 - a. tran-esterification of oil containing tocotrienols/tocopherols, carotenes, sterols, fatty acids, mono-, di- and triglycerides, for a period of time at specific temperature in the presence of a monohydric alcohol, and base or acid to form an ester-rich layer and a glycerol-rich layer;
 - b. separating the ester-rich layer from the glycerol-rich layer as obtained in (a) by gravitational settling, decantation or separation by centrifugal forces;
 - c. washing and drying the ester-rich layer obtained in (b) under conditions sufficient to remove all impurities and base or acid without destroying the tocotrienols, tocopherols and carotenoids in the ester-rich layer;
 - d. step-wise molecular distillation or any other distillation of the resultant dried ester-rich layer as obtained in (c) to yield a concentrated mixture of tocotrienols/tocopherols, carotenoids and sterols at specific temperature and pressure;
 - e. further trans-esterification of the mixture obtained in (d) containing concentrated tocotrienols/tocopherols, carotenes, sterols, and fatty acids, mono-, di- tri glycerides, for a period of time at specific temperature in the presence of a monohydric alcohol, and base or acid to convert glycerides in the oil to form an ester-super-rich layer and a glycerol-rich layer; and
 - f. repeating the above trans-esterification reactions and step-wise molecular distillations to achieve the desired concentration of tocotrienols/tocopherols, carotenoids, and sterols.

2. (Previously presented) The process according to claim 1, wherein the concentrated carotenoids are treated with a lower alkyl alcohol under conditions sufficient to form carotenoids miscelles without destroying the carotenoids, thereby forming a carotenoid-rich layer.
3. (Previously presented) The carotenoid-rich layer according to claim 2, wherein the said carotenoid-rich layer is subjected to an evaporation or distillation process to distill out the lower alkyl alcohol to form a concentrated carotenoid extract.
4. (Previously presented) The process according to claim 1, wherein the concentrated tocotrienols/tocopherols/sterols mixture is treated with a low monohydric alcohol for a period of time at specific temperature to crystallize out the sterols and mono-, di-, and tri-glycerides from the mixture.
5. (Previously presented) The concentrated tocotrienols/tocopherols/sterols mixture according to claim 4, wherein the said mixture is subjected to a solid-liquid filtration to yield a rich tocotrienols/tocopherols filtrate and sterols cake.
6. (Previously presented) The tocotrienols/tocopherols filtrate according to claim 5, wherein the said filtrate is subjected to an evaporation or distillation process to distill out the lower alkyl alcohol to form a concentrated tocotrienols/tocopherols extract.
7. (Previously presented) The sterols cake according to claim 5, wherein the sterols cake is treated with appropriate solvents for a period of time at specific temperature to concentrate the sterols.
8. (Previously presented) The concentrated tocotrienols/tocopherols extract obtained from the crystallization process as in claim 4, wherein the said

tocotrienols/tocopherols concentrate is treated with appropriate solvents and absorbents, bleaching earth or activated carbon for a period of time at specific temperature to reduce the color, and to obtain a lighter colored tocotrienols/tocopherols concentrate.

9. (Previously presented) The process according to claim 1, wherein the oil used in the transesterification is selected from the group consisting of crude palm oil, crude palm olein, red palm oil, red palm olein, vegetable oil and any other suitable edible oil.
10. (Previously presented) The process according to claim 1, wherein glycerides in the oil are converted to fatty acid alkyl esters and glycerol, and to form an ester-rich layer and a glycerol-rich layer, by contacting the oil with an esterification solution comprising lower alkyl alcohol and a base or acid.
11. (Previously presented) The process according to claim 1, wherein the ratio of oil to the esterification solution is in the range between 0.5 - 10 part of oil to 1 part esterification solution.
12. (Previously presented) The process according to claim 1, wherein the base used in the esterification solution is selected from a group consisting of sodium methoxide, potassium methoxide, sodium hydroxide, potassium hydroxide, and any other suitable base.
13. (Previously presented) The process according to claim 1, wherein the ratio of base to lower alkyl alcohol in the esterification solution is in the range between 0.005 to 5 part of base to 1 part of lower alkyl alcohol.
14. (Previously presented) The process according to claim 1, wherein the acid used is selected from a group consisting of hydrochloric acid, phosphoric acid, citric acid and any other suitable acid.

15. (Previously presented) The process according to claim 1, wherein the ratio of acid to lower alkyl alcohol in the esterification solution is in the range between 0.005 to 5 part of acid to 1 part of lower alkyl alcohol.
16. (Previously presented) The process according to claim 1, wherein the lower alkyl alcohol used is selected from the group consisting of methanol, ethanol, butanol, propanol and any other suitable lower alkyl alcohol.
17. (Previously presented) The process according to claim 1, wherein the trans-esterification is carried out at a temperature ranging from 5°C to 90°C with a time period ranging from 0.50 hour to 16 hours.
18. (Previously presented) The process according to claim 1, wherein the trans-esterification mixture is agitated at a speed of between 10 rpm to 500 rpm.
19. (Previously presented) The process according to claim 1, wherein the alkyl esters produced comprise methyl, ethyl, and isopropyl or butyl esters of the fatty acids, depending on the type of lower alkyl alcohol used.
20. (Previously presented) The process according to claim 1, wherein the ester-rich layer or ester-super-rich layer is separated from the glycerol-rich layer by conventional gravitational settling or centrifugal forces.
21. (Previously presented) The process according to claim 1, wherein the ester-rich layer or ester-super-rich layer is washed with either hot or cold water via direct contact with the hot water or through a counter-current hot water column at a temperature ranging between 30 to 90°C.

22. (Previously presented) The process according to claim 1, wherein the ester-rich layer or ester-super-rich layer is washed with hot water until a pH of 6 to 8 is reached.
23. (Previously presented) The process according to claim 1, wherein the washed ester-rich layer or ester-super-rich layer is subjected to vacuum evaporation or wiped film evaporator or short path distillation to achieve a moisture content of between 0.001% to 0.20%.
24. (Previously presented) The process according to claim 1, wherein the dried ester-rich layer or ester-super-rich layer is subjected to a multi-stage molecular distillation at a temperature ranging from of 50°C to 300°C and at a vacuum of 0.00001 to 1.0 mbar.
25. (Previously presented) The process according to claim 1, wherein the mixture obtained in 1(d) comprises a concentrated mixture of tocotrienols/tocopherols, carotenoids and sterols at a concentration of between 0.1-10%, 0.1-10% and 0.1-10% respectively.
26. (Previously presented) The process according to claim 1, wherein the multi-stage molecular distillation of the dried ester-super-rich layer will produce tocotrienols/tocopherols/sterols extract as the distillate and carotenoids extract as the residue.
27. (Previously presented) The process according to claim 1, wherein the content of tocotrienols/tocopherols/sterols in the distillate is 5% to 30% total tocotrienols/tocopherols and 5%-50% total sterols and carotenoids content in the residue is between 5% - 30%.
28. (Previously presented) The process according to claim 2, wherein the lower alkyl alcohol used in alcoholic washing is selected from the group consisting of

methanol, ethanol, propanol, butanol, isopropyl alcohol and any combination of these alkyl alcohols.

29. (Previously presented) The process according to claim 2, wherein the washing and agitation time ranges from half an hour to 30 hours and the temperature ranges from between 5°C to 90°C.
30. (Previously presented) The process according to claim 2, wherein the concentrated carotenoids extract has a concentration of between 20%-50% total carotenoids.
31. (Currently amended) The process according to claim 2, wherein the concentrated carotenoids extract consists of alpha-carotene and beta-carotene as the major carotenoids and other carotenoids ~~such as gamma-carotene, lycopene, phytoene and phytofluene~~ at lower concentration.
32. (Previously presented) The process according to claim 4, wherein the lower alkyl alcohol used in the crystallization of tocotrienols/tocopherols/sterols mixture is selected from the group consisting of methanol, ethanol, propanol, butanol and any combination of these alkyl alcohols.
33. (Previously presented) The process according to claim 4, wherein the crystallization temperature ranges from 60°C to 0°C for a period ranging from 3 hours to 10 days.
34. (Previously presented) The process according to claims 4, wherein the evaporation temperature ranges from 10°C to 90°C.
35. (Previously presented) The process according to claim 4, wherein the resulting tocotrienols concentrate has a total concentration of tocotrienols and tocopherols ranging from between 20% to 90%.

36. (Currently amended) The process according to claim 4, wherein the resulting tocols concentrate comprises ~~all eight forms of vitamin E, namely, alpha-tocopherol, beta-tocopherol, gamma-tocopherol, delta-tocopherol and alpha-tocotrienol, beta-tocotrienol, gamma-tocotrienol and delta-tocotrienol.~~
37. (Currently amended) The process according to claim 4, wherein the resulting tocols concentrate may also contain ~~other compounds such as~~ squalene, sterols, carotenoids and CoQ10 with typical concentration ranging between 0.5 % - 20%, 0.5% - 20%, 0.05% - 10% and 0.001 % - 2% respectively.
38. (Previously presented) The process according to claim 5, wherein the solvent used in the purification of sterols is selected from the group consisting of hexane, heptane, iso-octane, acetone, ethyl acetate and any combination of these solvents, in the ratio ranging from between 1:1-10:1.
39. (Previously presented) The process according to claim 5, wherein the crystallization of sterols is carried out at a temperature ranging from 30°C to 10°C for 12 to 72 hours and the resulting filtered and dried sterols have a total phytosterols content ranging from 70% to 90%.
40. (Previously presented) The process according to claim 5, wherein the temperature range of the purification of sterols is between 10°C to 80°C and the time period ranges from 1 to 10 hours.
41. (Previously presented) The process according to claim 8, wherein the temperature range of the decolourization process is between 10°C to 90°C and the time period ranges from 1 to 24 hours per batch.
42. (Previously presented) The process according to claim 8, wherein the mixture is agitated in the range from 10 rpm to 1000 rpm.

43. (Previously presented) The process according to claim 8, wherein the mixture after reaction is filtered with filter press or vacuum filtration or centrifugation or simple settling and the resulting filtrate is evaporated at temperature ranging from 10°C to 90°C and at a vacuum of between 1 mbar to 0.0001 mbar.
44. (Previously presented) The process according to claim 8, wherein the final decolourized tocots concentrate has a colour range of between 1R to 20R when measured with a 5-1/2 inch cell of the Lovibond Tintometer.
45. (Previously presented) Tocotrienols, tocopherols, carotenoids and sterols produced from oils according to the process as in claim 1.
46. (Previously presented) The process according to claim 12, wherein the ratio of base to lower alkyl alcohol in the esterification solution is in the range between 0.005 to 5 part of base to 1 part of lower alkyl alcohol.
47. (Previously presented) The process according to claim 14, wherein the ratio of acid to lower alkyl alcohol in the esterification solution is in the range between 0.005 to 5 part of acid to 1 part of lower alkyl alcohol.
48. (Previously presented) The process according to claim 26, wherein the content of tocotrienols/tocopherols/sterols in the distillate is 5% to 30% total tocotrienols/tocopherols and 5% - 50% total sterols and carotenoids content in the residue is between 5% - 30%.
49. (Previously presented) The process according to claim 3, wherein the lower alkyl alcohol used in alcoholic washing is selected from the group consisting of methanol, ethanol, propanol, butanol, isopropyl alcohol and any combination of these alkyl alcohols.

50. (Previously presented) The process according to claim 3, wherein the washing and agitation time ranges from half an hour to 30 hours and the temperature ranges from between 5°C to 90°C.
51. (Previously presented) The process according to claim 3, wherein the concentrated carotenoids extract has a concentration of between 20%-50% total carotenoids.
52. (Previously presented) The process according to claim 3, wherein the concentrated carotenoids extract consists of alpha-carotene and beta-carotene as the major carotenoids and other carotenoids such as gamma-carotene, lycopene, phytoene and phytofluene at lower concentration.
53. (Previously presented) The process according to claim 5, wherein the lower alkyl alcohol used in the crystallization of tocotrienols/tocopherols/sterols mixture is selected from the group consisting of methanol, ethanol, propanol, butanol and any combination of these alkyl alcohols.
54. (Previously presented) The process according to claim 6, wherein the lower alkyl alcohol used in the crystallization of tocotrienols/tocopherols/sterols mixture is selected from the group consisting of methanol, ethanol, propanol, butanol and any combination of these alkyl alcohols.
55. (Previously presented) The process according to claim 5, wherein the crystallization temperature ranges from 60°C to 0°C for a time period ranging from 3 hours to 10 days.
56. (Previously presented) The process according to claim 6, wherein the crystallization temperature ranges from 60°C to 0°C for a time period ranging from 3 hours to 10 days.

57. (Previously presented) The process according to claim 5, wherein the evaporation temperature ranges from 10°C to 90°C.
58. (Previously presented) The process according to claim 6, wherein the evaporation temperature ranges from 10°C to 90°C.
59. (Previously presented) The process according to claim 5, wherein the resulting tocols concentrate has a total concentration of tocotrienols and tocopherols ranging from between 20% to 90%.
60. (Previously presented) The process according to claim 6, wherein the resulting tocols concentrate has a total concentration of tocotrienols and tocopherols ranging from between 20% to 90%.
61. (Currently amended) The process according to claim 5, wherein the resulting tocols concentrate comprises ~~all eight forms of vitamin E, namely, alpha-tocopherol, beta-tocopherol, gamma-tocopherol, delta-tocopherol and alpha-tocotrienol, beta-tocotrienol, gamma-tocotrienol and delta-tocotrienol.~~
62. (Currently amended) The process according to claim 6, wherein the resulting tocols concentrate comprise ~~all eight forms of vitamin E, namely, alpha-tocopherol, beta-tocopherol, gamma-tocopherol, delta-tocopherol and alpha-tocotrienol, beta-tocotrienol, gamma-tocotrienol and delta-tocotrienol.~~
63. (Currently amended) The process according to claim 5, wherein the resulting tocols concentrate may also contain ~~other compounds such as squalene,~~ sterols, carotenoids and CoQ10 with typical concentration ranging between 0.5 % - 20%, 0.5% - 20%, 0.05% - 10% and 0.001 % - 2% respectively.
64. (Currently amended) The process according to claim 6, wherein the resulting tocols concentrate may also contain ~~other compounds such as squalene,~~

sterols, carotenoids and CoQ10 with typical concentration ranging between 0.5 % - 20%, 0.5% - 20%, 0.05% - 10% and 0.001 % - 2% respectively.

65. (Previously presented) The process according to claim 7, wherein the solvent used in the purification of sterols is selected from the group consisting of hexane, heptane, iso-octane, acetone, ethyl acetate and any combination of these solvents, in the ratio ranging from between 1:1-10:1.
66. (Previously presented) The process according to claim 7, wherein the crystallization of sterols is carried out at a temperature ranging from 30°C to 10°C for 12 to 72 hours and the resulting filtered and dried sterols have a total phytosterols content ranging from 70% to 90%.
67. (Previously presented) The process according to claim 7, wherein the temperature range of the purification of sterols is between 10°C to 80°C and the period ranging from 1 to 10 hours.